ART. V. — 1. *Elements of Physiology*, by J. MÜLLER, M. D., Professor of Anatomy and Physiology in the University of Berlin, etc. *Translated from the German, with Notes*, by WILLIAM BALY, M. D., Graduate in Medicine of the University of Berlin. Illustrated with Plates and numerous Wood Engravings. Second Edition, with Corrections and numerous Additions. London: Taylor and Walton. 1840 and 1842. 2 vols. 8vo. pp. 1715.

2. *Elements of Physiology*, by J. MÜLLER, M. D., etc.; arranged from the Second London Edition, by JOHN BELL, M. D., Lecturer on Materia Medica, &c. Philadelphia: Lea and Blanchard. 1843. 1 vol. 8vo.

ONE of the great characteristics of the present state of natural science is the elucidation which its different departments are capable of affording to each other. In the application of comparative anatomy to geology, we have a striking illustration of this proposition. These two sciences, which appear, at first sight, so distinct and unconnected, the object of the one being to determine the laws of animal organization, and of the other to ascertain the structure of the earth, and the changes which it has undergone, are yet most intimately united, and afford indispensable aid to each other. Comparative anatomy determines, with unerring accuracy, the nature of the extinct races of animals, remains of which are found almost everywhere in the superficial crust of the earth; and geology spreads out before the anatomist a far more extended view of animal organization than could be learned by studying only the existing species. Great as have been the results of the application of this science to geological investigation, there can be no doubt that its importance will be still more enhanced, in consequence of the light which it has already begun to throw on the science of Physiology in general, and especially on the physiology of man.

As a department of natural science, human physiology has been slow and variable in its progress; not, however, from the want of a sufficient number of laborers, or from inadequate zeal on the part of those who have devoted themselves to it; but rather from the want of a philosophical

method in physiological inquiry, as well as from the difficulty which organized beings, through the obscure nature of their properties, and the complexity of the combinations of their parts, are constantly throwing in the way of the student. Since the great impulse given to zoölogical and anatomical pursuits by the gigantic labors of John Hunter in England, and the more extended researches of Cuvier in France, a better day seems at length to have dawned. The vain speculations of the old school of physiologists with regard to the functions of organs, founded, for the most part, on gratuitous assumptions, have given way to more rational methods of inquiry. The physiologist of the present day seeks other and better sources of information, and finds the laboratory of the chemist, the hospital, and the dissecting-room, unfailing sources of light and truth. He no longer contents himself with studying human organization, but receives aid at every step from investigating that of the lower orders of animals. Anatomists had labored long and hard in their attempts to ascertain the functions and comparative importance of different organs; to this end, they have subjected animals without number to the cruel tortures of vivisection, and, after all, have met, in most instances, with indifferent success. The result would doubtless have been very different, had they studied, with equal zeal, the numerous forms and varieties of structure which comparative anatomy now unfolds to our view, and which constitute to the eye of the true observer, as Cuvier has well remarked, "so many kinds of experiments, already prepared by Nature, who adds or takes away different parts, just as we might wish to do in our laboratories, and shows us, at the same time, the various results."

The most extended researches into animal organization have shown, that, however great may be the difference between those creatures which severally constitute the great divisions of the animal kingdom, the anatomical structure of all the members of one division is formed on the same general plan. Such, for instance, is the case with the Vertebrate, Articulate, and Radiate classes. Ascending from organization to the laws which regulate its action, we find that there is sufficient ground for the belief, that the general laws of vitality are the same throughout the whole animal creation, and one of the most distinguished English physiologists

of the present day goes so far as to say, that "it is a great mistake to suppose that there is any thing fundamentally different in the character of the vital operations, as performed in the animal and vegetable structures, or in the simpler and more complicated organisms of either kingdom."* At all events, it appears perfectly clear that an enlarged and comprehensive idea of life and organization can only be acquired by investigating the varied phenomena presented by organized beings, in whatever form or whatever degree of development they may be found to exist.

To the German school of physiologists belongs the credit of having introduced into their systems the structure and functions of the organs of the lower orders of animals, in illustration of that of man. Although we find, in the works of Tiedemann and others, ample use made of the light furnished by comparative anatomy, yet we are not aware that any one, either in Germany or in any other country of Europe, has done so much in this respect as Müller, who is confessedly at the head of the German school.

Every page of his work on Physiology shows that no means of investigation have been allowed to escape him, which were capable of affording aid. Physics, organic chemistry, the comparative anatomy of plants and animals, all lend a helping hand in unravelling the secrets of human organization. We know of no work which is better calculated to illustrate the truth of the proposition at the head of this article, nor one which more fully confirms the often quoted remark of Cicero respecting the common bond which unites all the arts and sciences. In the present notice, we do not propose to enter into any thing like an analysis of the work, which is so concisely written as scarcely to allow even of abridgment, but rather to take up some detached subjects, which may prove interesting to the general reader.

The work begins with "general prolegomena," in which we find an exposition of the general properties of organic beings, and of the characteristics by which animal and vegetable organisms are distinguished from each other, together with some considerations on the manifestation and evolution

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* Carpenter's *Principles of General and Comparative Physiology.* 2d Edition. London, 1841. p. 4.

in living beings of the imponderable agents, light, heat, and electricity. On two of these subjects we propose to offer a few remarks ; and first, on a subdivision of one of them, relating to the theory of Equivocal or Spontaneous Generation.

It is now generally admitted with regard to all organized beings, whether animals or plants, the most simple and least known only excepted, that one of the characteristics by which they are distinguished from inert brute matter is the fact, that they owe their origin to other beings precisely similar to themselves, and of which they are the true offspring. The opposite ground, however, is maintained by the advocates of spontaneous or equivocal generation; namely, that living organisms do make their appearance in places where no similar being ever existed before. This is the remnant of a doctrine which has come down to us from remote antiquity, when it was considered applicable to the primeval state of the whole animal kingdom ; but its adherents were obliged to admit, that animals, having been once spontaneously generated, were afterwards capable of producing their like. Empedocles and Epicurus both embraced the doctrine, that all living beings originally came from the bosom of the mother earth, after which, each produced its like ; but they also admitted, that some of the lower orders, such as insects, were derived from the decayed bodies of other animals.* This theory, so far as it regards the greater portion of the invertebrate classes, was not abandoned till after the middle of the seventeenth century, when Harvey took up the defence of the doctrine of "*omne vivum ex ovo.*" The experiments of Redi, also, which were subsequently performed, were an important step in the progress of accurate knowledge, and overthrew, finally and decisively, the whole theory in relation to the insect race. He proved, by a series of experiments conducted in the most rigid and philosophical manner, that the worms or maggots, which swarm on the dead carcasses of animals, were nothing else than the larvæ, or immature and untransformed young, of true insects. He also succeeded in proving conclusively, that the larvæ themselves were produced from eggs deposited by flies or

* Redi, *Experimenta circa Generationem Insectorum*, p. 11.

other insects; and he witnessed their transitions through all the different stages, from the egg to the perfect state.

Although this was perfectly conclusive, as regards insects, yet the discoveries of Needham and others, by means of the microscope, soon afforded the advocates of the doctrine of equivocal generation a new and strongly fortified position, and one which they have continued to hold till the present time, though it is now so much weakened as to be scarcely any longer tenable. The experiments of Needham, Spallanzani, and others, demonstrated, that, during the decomposition of various organic matters, animal as well as vegetable, myriads of microscopic beings, now familiarly known as Infusory animalcules, made their appearance under such circumstances that it was impossible to trace their origin to other preëxistent beings similar to themselves. It was inferred, therefore, that their origin was spontaneous. Spallanzani labored hard to disprove this inference, but his experiments were not conducted in such a manner as to afford a rigid demonstration of the points which he intended to establish. But, in justice to this great naturalist, we are bound to admit, that the results of his observations have been confirmed by recent inquiries, even in cases which had been considered as wholly unworthy of credit. Ehrenberg, although he has sometimes refused, on insufficient grounds, to admit some of Spallanzani's observations, which have been quite recently repeated with success, has done more than other observers with the microscope, of the present day, to clear up the darkness which hung over the different races of animalcules; and the results of his investigations, so far as they go, are powerful arguments against the theory of the equivocal origin of these races. At present, the whole argument for the doctrine of equivocal generation rests upon facts furnished by microscopic organisms, as yet but little known or studied, and by that singular race of beings, inhabiting the interior of other animals, the Entozoa, whose history, from the obscurity of their situation, is necessarily but little understood. Although, in these cases, science is yet incapable of demonstrating their origin from preëxisting beings similar to themselves, still, the remark made by Cuvier, more than thirty years ago, is not less true at the present day, that, "although the impossibility of spontaneous generation cannot be absolutely demonstrated, yet all the

efforts of those physiologists who believe in the possibility of it have not succeeded in showing us a single instance." *

We come next to speak of the argument which is founded on the animalcules of Infusions. If a certain amount of animal or vegetable matter is placed in water, and exposed to the action of light and air at the common temperature of summer, we find, that, at the end of a few days, the decomposition of the organic matter has commenced, and that certain species of microscopic animalcules have made their appearance. Perhaps, at the same time, certain microscopic vegetable growths, such as moulds, confervæ, or simple detached cellules, become visible on the surface. These possess all the properties common to organic beings, and the question naturally presents itself, From what are they derived? Are they spontaneously generated from decomposing organic matter, or are they derived from *ova*, which previously existed in a latent state, and have now, for the first time, found a *nidus* favorable to their development? Supposing them to be derived from *ova*, are these contained in the organic matter undergoing the process of decomposition, or do they come from the water, or the air?

"Wrisberg observed that no animalcules are produced when atmospheric air is excluded, for instance, when the surface of the infusion is covered with olive oil. They are generated by an infusion of any animal or vegetable matter, which contains nothing acrid or acid, and nothing which would prevent putrefaction. The development of infusoria commences as soon as a certain degree of decomposition with escape of gas has taken place. From this period, also, a large number of microscopic molecules, produced by the dissolution of the organic matter, are seen in the infusion, sometimes diffused in it, sometimes forming a kind of membrane at its surface. Fray and Burdach state, that infusory animalcules are also generated in an atmosphere of hydrogen and nitrogen.

"Spallanzani, and several other physiologists, attacked this theory of the equivocal generation of animalcules. Spallanzani explained the production of these animals, by supposing ova to have been present in the fluid, and to be developed by the influence of warmth, water, air, and light. This physiologist's own experiments, however, show that organic substances do not lose

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* Cuvier, *Rapport Historique sur les Progrès des Sciences Naturelles depuis* 1789. Paris, 1810. p. 194.

their property of producing animalcules by being boiled, and that distilled water is as well adapted for making the infusion as other water. Besides, his observations merely prove that atmospheric air is necessary for the development of these animalcules; that, when bottles, filled with infusions, and hermetically closed, were exposed for an hour to boiling heat in vessels filled with water, no animalcules were discoverable in these infusions when afterwards examined. Spallanzani also found, that the animalcules differ according to the nature of the infusion. From experiments with the seeds of the water-melon, gourd, hemp, and millet, it resulted, that the number of the Infusoria is greater when the germ is in the progress of growth than when the seed is just germinating, and that the number diminishes as the seed decays. The smaller kinds of animalcules were succeeded by larger, until, after a certain time, the power of developing them seemed to be lost. The infusory animalcules from uninjured seeds were said to be larger than those from pulverized seeds. They were generated from flour quite as well as from seeds merely bruised. If, however, the starch of the flour was separated from the gluten, and an infusion made of each of these substances separately, very few animalcules, or none at all, were developed in the infusion of starch, while in that of the gluten a host of living animals were seen. In infusions of barley, Indian wheat, beans, lupin-seeds, rice, and linseed, no animalcules were developed. But, since the genera and species of Infusoria are as determinate as those of higher classes of animals, and since Spallanzani has not particularized the differences of form of his Infusoria, since, moreover, the forms of the Infusoria in the different stages of their development are not known, Spallanzani's experiments lose much of their weight in reference to his discovery of perfectly different animalcules in the infusions of the gourd, chamomile, sorrel, corn, and spelt.

"Treviranus has, by his numerous and more accurate experiments, given a much greater importance to the hypothesis of equivocal generation. The following are the grounds of his arguments; —

"1. Infusions, with the same water, of different organic substances, — for instance, cress-seeds and rye, — give rise to different animalcules.

"2. Light has a very great influence on the process of equivocal generation. Thus, the green matter of Priestley, which is remarkable for its property of exhaling oxygen, is produced only under the influence of light; when water, particularly spring-water, is exposed to the sun in transparent vessels, whether open or close, this matter appears in the form of a greenish crust,

consisting of round or elliptic granules, and presenting at first only slight motions of single molecules, while afterwards transparent threads moving irregularly are discoverable in it. These changes have been most fully observed by Ingenhouss. According to Professor R. Wagner, the green matter of Priestley (generally supposed to be formed of the simple vegetable cells, the Protococcus) consists of the remains of green animalcules, the Euglena viridis, and others, which have died. In that case, the moving threads would be independent beings, distinct from the green matter, and Ingenhouss would have committed the error of regarding different kinds of simple beings as different states of the same molecules.

"3. The Entozoa, and the Spermatozoa, bodies with tails and spontaneous motions, which are seen by the microscope in the seminal fluid, even of invertebrate animals, seem to afford arguments for the spontaneous origin of living beings in organic matter.

"4. Treviranus found in his own experiments, that, under circumstances otherwise similar, different organic beings, namely, Infusoria or Algæ (mould), are formed in different infusions; and he ascertained that these differences did not depend on the water, but on the substances infused in it.

"5. Treviranus observed, that in the same infusion, under different accidental conditions, different animalcules were developed; thus, from an infusion of the leaves of the iris with fresh spring-water, in a long vessel covered with linen, and exposed to the sun, infusory animalcules were generated; in another vessel, placed in another situation, the green matter of Priestley was formed. Thus also the products in the same infusion of rye with spring-water were different, when Treviranus placed a bar of iron in one of the vessels. This result seems to agree with that of Gleditsch, who found, that in separate portions of melon covered with muslin, and placed at different heights, the various living organic substances, namely, mould, byssus, and tremellæ, were produced in different proportions. To this might be added, that Gruithuisen states, that he has found perfectly different animalcules in infusions of pus and mucus.

"From all these facts Treviranus has inferred, that throughout nature there exists an absolutely indecomposible, indestructible (?), organic matter, which is constantly active; which is the cause of life in every thing living, from the byssus to the palm, and from the point-like infusory animalcule, to the monsters of the deep; and which, in its essence unchangeable, is constantly changing its form; that this matter has itself no proper form, but is capable of assuming every one in which life is manifested;

that it receives a determinate form only under the influence of external causes, retains it only during the continuance of these causes, and takes another as soon as other causes act upon it.

"According to Wrisberg and others, the animalcules are formed from particles which separate from the substance infused, and which gradually begin to move; while Gruithuisen says, that they appear first in the solution of extractive matter obtained by the action of water on the infused substance. Professor Schultze remarks, 'I have never seen a globule of blood, or of milk, or of cerebral substance, begin to move about in their several infusions, as a monad, or become changed into one. Every single globule, by its solution, affords matter for the production of several hundred monads.' This last observation, however, does not agree with the results of measurement; Ehrenberg estimates the smallest possible monad at about $\frac{1}{2000}$ of a line, that is $\frac{1}{24000}$ of an inch; while the corpuscules of human blood are only $\frac{1}{3700}$ — $\frac{1}{4600}$ of an inch in diameter, and the globules of the milk are still smaller. Schultze states, that he has observed the conversion of dust-like particles of organic matter into Infusoria; these particles in the water become, he says, in a few hours surrounded by a turbid ring, which extends until the particle is quite dissolved; and then separates into monads." — Vol. I. pp. 11 – 14.

To these experiments and observations may be added a fact which recently fell under the observation of Dumas, the distinguished organic chemist of the School of Medicine in Paris. Having produced artificially, by the direct combustion of oxygen and hydrogen, a kilogramme of water, he noticed, after a certain period, that a vegetable mucosity had made its appearance on the inner surface of the glass in which it was contained, which was closed by a ground-glass stopper.

These instances furnish nearly all the arguments which can be advanced in favor of the spontaneous generation of animalcules. Müller objects to the whole of them, as insufficient to establish the point in question. None of them, he thinks, were conducted with sufficient accuracy to preclude the possibility of germs existing in one or the other of the substances used in the experiments, or in the air by which they are surrounded. The experiments of Spallanzani, as confirmed by later observers, with regard to the revivification of animalcules, especially the Rotifer, prove that these beings may exist in a dried state for a certain period,

during which time they resemble particles of dust; and, on a new application of moisture, they are revivified, or, as Spallanzani himself expressed it, they undergo the process of *resurrection.* Although other observers, besides Spallanzani, have succeeded in effecting this supposed resurrection, yet the manner in which the experiments were conducted does not afford demonstrative evidence of the truth of the results ascribed to them. On this ground they have been contested, and, more recently, Ehrenberg has added his authority to the opposition, rejecting them entirely, and attempting to show the source of error. The subject has been taken up anew by one of the French naturalists, M. Doyère, who has taken all the precautions necessary to preclude error, and has succeeded entirely in refuting the objections to Spallanzani's experiments. As this is an interesting subject, in a physiological point of view, we give an abstract of the report, made by a Commission of the Academy of Sciences in Paris, on the experiments of M. Doyère.*

The animals on which Spallanzani made his experiments, belonged to the genera *Rotifera* and *Tardigrada*, which inhabit the moss growing on the roofs of houses, and the sand and dust found in the gutters of the roof, and which often become perfectly dry, but assume an active state, whenever they are moistened with water. Spallanzani believed, that these animalcules were capable of being desiccated without losing their vitality, which was completely restored on the application of moisture. His opponents, among whom is Ehrenberg, contend that they are amphibious, and capable of living either in the water or in imperfectly dry sand; so that, in examining sand which has been for a long time more or less dry, we have an entirely different generation from the one which existed at the time when the water began to disappear, — or, as Ehrenberg says, they are only the great-grandchildren of those observed in the same matter at the commencement of the experiment. By others, it is admitted, that, although the animals themselves die when the sand is deprived of its moisture, the ova are preserved unimpaired, and by a new application of water they are rapidly developed. Lastly, some maintain that the desiccation is

* See *Microscopic Journal,* No. 20. London. October, 1842.

incomplete, going so far, only, as to render the animals torpid, and, though to all appearance dead, they actually preserve a latent life.

The results of Doyère's experiments set all these matters at rest. He has not succeeded in finding *living* Tardigrades in the dry dust, but he shows, that, by the aid of the microscope, corpuscles can be seen, which perfectly resemble the dead bodies of these animalcules, deformed by desiccation, and that, in matter where no living being was previously discernible, living Tardigrades frequently appear on the addition of a little distilled water. M. Doyère is even assured, that it is not impossible to revivify them, if taken one by one and dried separately on a piece of glass, without being surrounded by sand or other material, organic or inorganic. In his experiments, he has been able to count them, and to trace in each individual all the phases of desiccation ; to observe them gradually assuming the appearance of dead bodies, and to determine that these same bodies, dry and brittle, are susceptible of reassuming their primitive form and returning to life, under the influence of a few drops of water. This desiccation was not effected merely by the natural and spontaneous evaporation of the fluids exposed to the air, but was carried still further, by confining the animals, dried on slips of glass, for the space of five days, in the vacuum of an air pump, over a vessel containing sulphuric acid ; others were left thirty days in a Torricellian vacuum, dried by chloride of lime, and, in all these instances, he obtained some resurrections. The experiments did not rest here, but were pushed in another direction, in order to ascertain the effect of different temperatures on these singular beings.

It is known that some animalcules perish when their temperature is raised above a certain limit, inferior, however, to that at which the white of egg coagulates, and which, in the majority of cases, does not exceed 122° F. M. Doyère is satisfied that Rotifers and Tardigrades are not excepted from this law, but perish when the water in which they swim is heated to 105° F. ; and that they cannot then be recalled to life by any means. This, however, is not the case when they have been previously dried. If, instead of experimenting upon those in full life, it is done upon those which have lost all their humidity by the ordinary means of

desiccation, and which appear as dead, it is possible, without depriving them of the faculty of revivifying, to raise their temperature to a degree which would necessarily involve the disorganization of all living tissue containing water beyond that chemically combined with its constituent principles. In an experiment, repeated in the presence of the Commission of the Academy, a certain quantity of moss, containing *Tardigrada*, after having been properly dried, was placed in a stove, and around the bulb of a thermometer, the stem of which extended out of the apparatus. Heat was gradually applied, till the thermometer thus placed rose to 248° F. This temperature was maintained for several minutes; and yet some of the animalcules contained in the moss returned to life, and appeared in their usual condition, after having been placed twenty-four hours in water.

These facts are of much importance for the solution of the question at issue. The result is certainly affected by a circumstance, first pointed out by M. Chevreul, that albumen, deprived of its water by previous drying, can be submitted to a much higher temperature, without losing its solubility, than it could bear, if exposed in the same way in a moist state. From the simple fact, that a Tardigrade, exposed to the action of a temperature of 248 degrees, can still be made to revive, it may be concluded, with great probability, that it can live after the whole of the water chemically free in its body has been dissipated, a degree of desiccation which would seem to preclude the idea of vital movement. Thus the *Tardigrada* and *Rotifera*, when dry, cannot be considered as actually alive, but their mode of existence may be compared to that of a seed, which is organized so as to germinate when exposed to the influence of the air, of water, and of heat; but which, in the absence of any one of these excitements, manifests no sign of activity or life, and can be preserved thus for ages, although the duration of its active life may not exceed, perhaps, a few weeks.

Although we cannot assert, with M. Doyère, that an animalcule may wholly lose its vitality, and assume it again on the application of water, yet no one will refuse to admit, as one of the consequences of these experiments, what is already acknowledged by many naturalists, among whom is Humboldt, that animalcules, or their germs, may be desiccated, without

necessarily losing their vitality, and, when thus dried, that they are capable of being wafted about in the air, until they shall find a suitable *nidus* for their revivification. In experiments which are made in order to determine the origin of the animalcules of infusions, it will always be necessary, therefore, to take those precautions which will wholly remove this source of error, — the possibility of the animals being introduced from the atmosphere.

Another objection, which Müller makes to the argument for the spontaneous generation of animalcules, is based on the liability to error from the presence of the animals, or of their germs, in the water itself in which the experiments are made.

"The equivocal generation of Infusoria is not better proved by the experiments in which boiled organic substances and common water were used ; for the water may have contained the ova of Infusoria, or animalcules themselves, which have afterwards multiplied very rapidly at the expense of the organic matter in the infusion. The use of perfectly pure distilled water can scarcely be presupposed, for even water distilled five times may still contain organic particles.

"Those who have experimented with fresh organic substances and distilled water, or even artificially prepared gases, cannot prove that the ova of animalcules, or animalcules themselves, were not in some way contained in the organic substance ; the microscopic animalcules, which are known to exist in living tissues, are, indeed, few, and the common globules of the organic fluids, such as those of the blood, have certainly no individual life ; but mucus itself contains microscopic animals ; the intestinal mucus of the frog, as well as the semen, contains animalcules. Baer has seen microscopic particles moving spontaneously in different parts of mussels. The grain of wheat, and some varieties of agrostis, often contain vibriones, which, even after being dried, recover their active life, if moistened. Some Entozoa also, but still more some Epizoa, will continue to live when placed in water.

"Although some experimenters should have employed organic substances long boiled, with distilled water and artificially prepared air at the same time, still, the accuracy necessary for a sure result is neither probable nor generally possible ; since every instrument used for changing the water ought to be absolutely free from particles of organic matter, and every cleansing is a source of errors.

"*Ehrenberg's observations are opposed to the theory.* — The

foregoing remarks do not disprove the existence of equivocal generation; they merely show that it is scarcely possible to prove it by direct experiment. The investigations of Ehrenberg, however, relative to the organization of these animals and plants, which are supposed to be generated in this 'equivocal' manner, have thrown new doubt upon the theory. In the first place, Ehrenberg discovered the real germs of the fungi and algæ, or mould. The propagation of these organic bodies was thus established; it was shown, that, by means of the germs or seeds of the mould, new mould can be produced, which rendered it probable that the cases of the unexpected production of mould arose merely from germs, which had been diffused in the atmosphere or water, having then found the situation required for their development. With regard to the infusory animalcules, their complicated structure was first discovered by Ehrenberg; he found that the smallest monad, $\frac{1}{2000}$ of a line in diameter, has a complicated stomach, and organs of motion in the form of cilia. In others he observed the ova, and the propagation by ova. This excited the greatest doubt with regard to those earlier observations in which, the complicated structure of these animalcules being unknown, they were said to have been seen to originate in particles of the organic substance of the infusion. Ehrenberg has never succeeded in obtaining determinate forms of Infusoria, according to the nature of the infusion; and even by the most similar modes of performing the experiment, sometimes one, sometimes another set of animalcules were obtained. He believes that there are certain forms, of which the number is limited, which are most widely diffused; that the ova, or individuals, of these forms, may exist in all waters, even in some parts of plants, but perhaps only in the noxious parts; and that of these forms different kinds may be much multiplied, according to the kinds of ova, or individuals, which were in the water, or were introduced into it. The increase of these animals appears to be extraordinarily rapid. A single wheel-animalcule, *Hydatina senta*, which was watched for more than eighteen days, and which lives still longer, is capable of a fourfold increase in twenty-four or thirty hours; a rate of propagation which would afford in ten days a million of beings. This, in some measure, explains the extraordinary number of Infusoria in a drop of an infusion. Ehrenberg never observed any animalcules in dew or rain; but there are some which he has found, in Africa and Asia as well as in Europe, in sea water as well as in river water, in the depths of the earth, and at its surface. During their development, however, these animals seem to present many forms, and the forms dependent on the different stages

of development of one animalcule may be easily mistaken for examples of different species. From these observations Ehrenberg concludes, that all Infusoria are, like other animals, propagated from ova, — 'omne vivum ex ovo,' — and leaves it undecided, whether the ova are, or are not, in part really the product of a *generatio primitiva.*" — Vol. I. pp. 14 - 16.

The existence of the Entozoa, which inhabit the interior of other animals, lends much more support to the doctrine of equivocal generation than any facts observed respecting the Infusoria. The Entozoa form a class *sui generis*, and are, for the most part, quite distinct in their organization from any thing which exists external to the body. They are extremely numerous, as scarcely an animal can be found which does not furnish one or more species of them inhabiting the alimentary canal, the cellular and muscular tissues, the interior of the vascular system, the humors of the eyes, and even the cavities of the brain. We have no evidence that they come from without, for nothing like them can be found out of the animal organization; neither the earth, the water, nor the interior of plants, contains any races which resemble them. A tape-worm, an Ascaris, a Hydatid, is never met with except in the interior of another animal, and a great number of species can be found only in one kind of animal, each race having its own parasites, differing specifically from those of others. "Many of these Entozoa occur only in particular organs, and generally die when removed from the animal body. They have been observed even in the embryos; and a still stronger proof that they cannot be introduced from without is furnished by the fact, that they exist equally in animals who are strictly herbivorous, and whose food, therefore, cannot be suspected of being the vehicle by which either the animals themselves, or their ova, might be introduced. Even in carnivorous animals, the introduction of Entozoa from without can be admitted in a very few cases only; such are the facts, of the Echinorhynchus of the field-mouse having been sometimes found in the falcon, the worms of frogs in serpents, and the Ligula of fishes in the stomachs of wading and swimming birds."

Ehrenberg endeavours to set aside the doctrine of the equivocal generation of the Entozoa, on the ground, that, since they are provided with organs which are well known to contain ova, the ova themselves may be absorbed, and

carried by the circulation into all parts of the body, and thus find their way into particular organs, or secretions, and even pass by the milk from one individual to another. "It is certainly possible," says Müller, "that they may have originally found their way thither (into the interior of animals) from the fluids of the mother ; but the suppositions by which equivocal generation is here sought to be refuted are as improbable as that theory itself. The ova of Entozoa are evidently too large to enter the lymphatics of the organ in which the animal lives ; they are much too large to circulate in the capillary blood-vessels, of which the diameter is only $\frac{1}{3700}$ of an English inch ; the explanation of their occurrence in herbivorous animals by transmission from mother to young is, consequently, completely opposed to known *data* afforded by the micrometer, unless it be admitted that the smallest particle of germinal matter formed by Entozoa already existing was as capable of propagating them as the entire ovum."

From our ignorance of the habits and history of this singular race of animals, it is impossible to arrive at any very satisfactory conclusion respecting the manner in which they find their way into the interior of other animals, and the means by which their progeny is so far preserved as to insure a continuation of their respective species. A judicious and reflecting inquirer, however, will be slow to admit the possibility of their equivocal origin, when he considers that such a mode of generation is entirely without analogy in all races of organized beings, animal as well as vegetable, excepting only such as, from their microscopic size, or the obscurity of their localities, are as yet so little known that we cannot form an opinion with regard to their mode of reproduction ; and that almost every step in the progress of zoölogical knowledge adds something to the evidence in the opposite scale.

The only other subject treated of in the "general prolegomena," to which we propose to refer, is that of the manifestation of the imponderable agents in the different races of organized beings. Light, heat, and electricity are evolved by animals, but in very different degrees. Heat is evolved by all the higher orders, so that they are enabled to maintain a temperature independent of that of the surrounding air ; the same is also true with regard to many of the in-

vertebrate classes, especially the insects and worms; but experiments are wanting to prove the presence or absence of this power in many of the other races. The experiments of Pouillet demonstrate the evolution of electricity during the germination of vegetables, and Matteuci witnessed a deviation of the magnetic needle, of about 15° or 20°, when the liver and stomach of a rabbit were connected with the platinum ends of the wires of a delicate galvanometer. These manifestations, however, must be referred to the vital and chemical changes, like the evolution of heat, which are going on in the animal economy, independently of the will, or beyond the control of voluntary effort. But to this last statement, there are, among the fishes, a few wonderful exceptions. In addition to the organs common to them and the other members of the genera to which they belong, an apparatus, or battery, is found, destined expressly for the evolution of electricity in large quantities, which they charge and discharge at will, whenever the power is required for self-defence, or, perhaps, for other purposes, as yet unknown to naturalists.

The emission of light is peculiar to a portion of the invertebrate classes. Some of the animals belonging to the genus *Cydippe*, *Beroe*, and *Oceania*, among the *Acalephæ*, are remarkable for possessing this property; and these, with some of the marine microscopic Crustacea, are the principal causes of the phosphorescence of the ocean. Among insects, phosphorescent species of the genera *Lampyris Elater* and *Fulgora* are well known.

The subject of the manifestation of light, heat, and electricity is one of the most curious and interesting which animal physiology can present to our notice, but our limits will allow us to say only a few words respecting the electrical fishes.

The fishes which have the power of generating and accumulating electricity at will, as at present known, consist of a very limited number of species, and these belonging to very different natural families. The most remarkable and best known are certain varieties of the Torpedo, the *Gymnotus Electricus*, and the Malapterurus. The Torpedo is found in more localities than either of the others; as it is now known to exist in Europe, Africa, and near the coast of South America, where it has been described by Humboldt; and it has also

been quite recently noticed by Dr. Storer on the coast of Massachusetts. The electric organs of this fish are situated on each side of the head, filling up the large space which exists between the head and the anterior edge of the pectoral fin. Each organ is made up of numerous quadrangular, pentagonal, and hexagonal prisms, arranged vertically, side by side, and extending from the upper to the under surface of the body. Each prism consists of a thin, membranous exterior, surrounded with nerves and vessels, and containing a great number of thin, transverse *lamellæ* lying parallel, and one above the other, with a gelatinous fluid between them ; so that the whole organ may be said to consist of a series of membranous cells, containing fluid.

The most remarkable anatomical peculiarity noticeable in this apparatus is the enormous size of the nerves by which it is supplied. In the human body, the nerve known as the *nervus vagus*, pneumo-gastric, or eighth pair of cerebral nerves, is distributed principally to the œsophagus, the heart, the lungs, and the stomach. In the Torpedo, this same nerve is distributed to the œsophagus, gills, stomach, and electric organs. If we compare the nerves of the two together, we are struck with the enormous size of those of the fish. They are many times larger than the spinal marrow itself, and, at their origin, in the *medulla oblongata*, are provided with ganglia, which are actually larger than the whole of the brain. A branch of the fifth pair of cerebral nerves is also distributed to the anterior portions of these organs. In the *Gymnotus*, or electrical eel, the structure of the electrical apparatus, which forms nearly the whole bulk of the animal, is not materially different from that of the Torpedo. It consists of a series of membranous cells, filled with a fluid, but not arranged in prisms. These organs are four in number, two on each side of the body, extending nearly the entire length of the animal, which, in its general outline, resembles the common eel. The organs of the *Gymnotus* do not receive their nervous influence from the same sources as those of the Torpedo, but are supplied by two hundred and twenty-four pairs of nerves, which are derived entirely from the spinal marrow.

The effects of the electrical discharges are, for the most part, the same in the Torpedo and *Gymnotus*, though in some particulars they differ. The electricity itself has been proved

by satisfactory experiments to be identical with that manifested in the ordinary way in the physical world. By the shocks or discharges from these animals, the galvanometer has been affected, sparks have been obtained, water decomposed, and needles magnetized. The power of producing the electric discharges is voluntary; and ceases entirely on the destruction of the brain. The *Gymnotus* not only evolves electricity at will, but has the power of determining the direction in which the discharges shall act. When Humboldt and Bonpland seized one of these fishes, one grasping the head and the other the tail, the shock was not always immediate; but, when it took place, it was sometimes given to one and sometimes to the other. The shocks from the *Gymnotus* are by far the most severe, and, to be affected by them, it is not necessary to touch it in more than one point; and the result is the same, if, instead of making the contact with the hand, an iron rod be interposed between it and the surface of the fish. If one hand only is laid upon it, a smart shock is generally felt in the hand and fore arm; if both hands are applied, the shock passes through the breast. "I do not remember," says Humboldt, "of having received from the discharge of a large Leyden jar a more dreadful shock than that I experienced by placing both my feet on a *Gymnotus* just taken from the water. I was affected through the day with a violent pain in the knees, and in almost every joint." The sensation produced by the shock of the *Gymnotus* is like that of the Leyden jar, while that of the Torpedo is compared to the sensation produced by the galvanic battery.

"Electric fishes which are still vigorous exert their electric power as strongly in the air as in the water. If several persons form the chain between the upper and under surfaces of the fish, the shock is not felt, unless these persons have previously moistened their hands. The discharge, however, is felt by two persons who, while grasping the Torpedo with their right hands, complete the circle, — not by holding each other by the left hands, but by each dipping a small bar of metal into a drop of water on an insulated body. Dr. J. Davy had observed that the dorsal and ventral surfaces of the electric organs of the Torpepo have different electric properties. This has been confirmed by Linari and Matteuci [and M. Colladon], who have found that the direction of the currents is from the dorsal to the ventral surface; and that the dorsal surface, therefore, may be regarded as

the positive, the ventral as the negative pole. [M. Colladon observed, that, when the wires were applied to two symmetrical points of the back or belly of the fish, no effect was produced on the galvanometer ; but that there was always distinct evidence of an electric current, when two non-symmetrical points of either surface were touched ; the part nearest to the electric organ being positive with relation to other parts on the back, and negative on the belly. Nearly similar results have been obtained more recently by M. Matteuci. He found that all points on the back, lying over the entrance of the nerves into the electric organs, were positive with relation to other points of the same surface, and that the corresponding points on the abdominal surface were negative with relation to all other parts of the belly ; and hence was enabled to explain the occurrence of currents when one surface of either electric organ was touched at two different points, or the same surface of both organs at non-symmetrical points. The interior of the electric organ being examined, it was found that each layer near to the dorsal surface was positive electric with regard to those nearer to the abdominal surface.] Spallanzani observed that the Torpedo loses its power of giving shocks when its skin is removed. Matteuci, however, states that the electric shock of the Torpedo is only weakened by the removal of the skin, and is felt even when slices of the organ are removed. But few truly physiological experiments have been hitherto performed on the nerves of the electric fishes. Dr. Davy observed that the electric discharges of a Torpedo continued after the brain of the fish was divided lengthwise ; but that, after the removal of the brain, no more shocks were given, even when the nerves of the electric organs were irritated. In one instance, when a small portion of brain had accidentally been left in connection with the electric nerves of one side, the fish gave a shock when irritated. M. Matteuci found that the intensity of the shock diminished in proportion to the number of the nervous fibres going to the organ which he divided, and that it was no longer given when all the nerves were severed. The death of the fish, produced by morphia, was attended with strong electric discharges and convulsions. When the animal had ceased to give shocks, even though irritated, discharges stronger than ordinary were excited by touching the part of the brain (an enlargement of the medulla oblongata) from which the nerves of the electric organs arise. [All parts of the brain in front of this fourth lobe or enlargement of the medulla oblongata may be removed without arresting the electric discharges. The cerebral hemispheres may be touched, wounded, or cut away, without any discharge being excited ; but

irritation of the optic lobes between the cerebral hemispheres and cerebellum sometimes caused an electric discharge, when the animal was vigorous.] From these results, M. Matteuci infers that the electric force of the Torpedo is not generated in the electric organs, that the current receives its direction from the brain, and that it is only strengthened in the former organs as in a Leyden phial or secondary pile. These conclusions appear to me, however, to be by no means justified by the foregoing facts; for, if the brain were the source of the electricity, its generation might be excited and its presence demonstrated even after the removal of the electric organs. The brain may charge these organs by exciting in them a heterogeneous chemical state, or it may merely cause them to discharge the electricity with which they have by their own energy charged themselves.

"A remarkable circumstance observed by M. Matteuci, in his more recent experiments, but requiring confirmation, was, that a galvanic current, directed through the nerves and electric organ of the Torpedo, excited a discharge, whether the current was made to pass from the nerves to the organ, or in the opposite direction; but that, when one pole was applied to the electric lobe of the brain and the other to the electric organ, no discharge was excited, unless the galvanic current was directed from the brain to the organ." — Vol. I. pp. 71, 72.

In order to give some idea of the manner in which the author treats the different subjects that fall within his province, we shall select a single chapter for analysis, as a more extended abstract would exceed our limits. For this purpose, we take up the chapter on respiration.

The end of the function of respiration is the introduction into the animal economy of a certain amount of oxygen, and the exhalation, or separation from it, of a certain amount of carbonic acid and water. At every moment, man is, by means of his lungs, borrowing from the air its oxygen, and, while life lasts, there can be no arrest of this process, beyond a few moments, without imminent danger. Lavoisier and Menzies have estimated, that, in the course of one year, man consumes from seven hundred to eight hundred pounds of this gas, and yet the weight of his body, at the end of that period, varies but little from what it was at the commencement. "The carbon and hydrogen of certain parts have entered into combination with the oxygen introduced from without, by means of the lungs and skin, and have been given out in the form of carbonic acid gas and the vapor of water.

At every moment, at every expiration, certain quantities of its elements separate from the animal organism, after having entered into combination, within the body, with the oxygen of the atmosphere." * Dumas, in his Lecture on Chemical Statics, referring to the changes which are continually going on in the animal economy, asks ; "Have we not proved, by a multitude of results, that, in a chemical point of view, an animal constitutes a true apparatus for combustion, in which carbon is incessantly being burned, and returned to the air, in the form of carbonic acid ; and in which hydrogen is also continually burned, and as continually forming water ; from which, in fine, azote is constantly exhaled in a free state from the lungs, and, in that of the oxide of ammonia, from the kidneys ?" †

This function, so important in man, is common to the whole animal kingdom, and is inseparable from animal existence. Its relative importance, however, is very variable ; for we find that the amount of oxygen consumed by worms and cold-blooded animals is very small. It varies much, as in the case of a bird compared with a fish, and yet so important is respiration to all, that to place an animal in a medium in which it cannot go on is a sure means, sooner or later, of destroying life. Müller, in treating of the organs by which the function is carried on, gives a general outline of the different forms which they assume in the different classes of animals, commencing with the more simple, and ascending to the more complex. Thus, we have a series of contrivances brought to our notice, varying in their degree of complication as we ascend from the lower to the higher classes, and these complications are commensurate with the extent and activity of the function. The series thus examined affords an illustration of the general proposition, that, as we descend in the animal scale, there is a tendency to dispense with the division of labor which is carried to so great an extent in the higher classes, and, instead of having a special organ appropriated to each function, we have all the functions performed, as it were, by a single organ, and that one is the whole body of the animal. Thus, in the *Hydra*, or fresh-water polypus, there is no organ appropriated specially to

* Liebig's *Animal Chemistry.* London, 1842. p. 13.
† *Leçon sur la Statique Chemique.* Paris, 1841. p. 4.

the function of respiration, but this takes place over the entire surface of the body, which surface is the only seat of sensibility, and is also capable of performing the office of a stomach ; for, according to the experiments of Trembley, this animal digests its food equally well, if completely turned inside out. What is here said of the organs of respiration is equally true in respect to the nervous, vascular, and other systems.

Respiratory organs are divisible into two kinds, according to the nature of the medium in which the animal lives, whether it be the air or the water. As it is from the surrounding medium that they all borrow their oxygen, the organs are varied to suit the conditions under which they exist. Aërial respiration is carried on, almost universally, by cavities which exist in the interior of the body, assuming the form of lungs, simple pouches, or complicated and ramified tubes. In all of these, however, the air is admitted into the interior of the organ. In aquatic respiration, on the contrary, excepting in the case of those animals in which it is effected by the entire surface, the organs assume the form of tufts, or fringes, or gills, and, in all cases, the surrounding medium comes in contact only with their external surface. For illustration, we will cite a few examples from the book ; and first, in relation to the aquatic races.

In the polypi, the whole surface, as has already been intimated, serves for respiratory action. In the infusory animalcules, the only respiratory organs seem to be the delicate vibrating filaments called *ciliœ*, with which, in many species, the surface is in part or wholly covered. They are so minute that the highest magnifying power is needed in order to perceive them. These *ciliœ* perform, also, the office of locomotive organs. In the aquatic mollusca and annelides, the respiratory organs are distinct, and usually assume the form of tufts or fringes, which are situated on the outer surface of the body, and float freely in the water. In other cases, they appear as thin laminæ, more or less concealed in the interior, accessible to the water, and are commonly known as gills. In the crustacea, the gills exist in a more complicated form ; and, in the fishes, they assume a more perfect organization than in any of the preceding classes.

Among animals breathing air, the terrestrial mollusca afford the simplest form of respiratory cavities. In the slug

and snail, we have a simple pouch excavated in the body of the animal, opening externally by an orifice distinct from the mouth, and generally at a distance from it ; and, on the inner surface of this cavity, the vessels ramify by which the blood is carried to and from the atmospheric influence. In a portion of the spiders we find a similar arrangement, but the pouches are more numerous, and the interior is more or less subdivided, so as to increase the amount of surface. Among the rest of the spiders, and in the whole class of insects, the respiratory organs consist of a series of minute and highly ramified tubes, which traverse every portion of the body, so that the air performs a circulation similar to that of the blood in the higher classes. Among the vertebrate classes, the reptiles have lungs constructed with the greatest degree of simplicity, consisting of large and hollow pouches, the surface of which is slightly subdivided into cells ; such is the case with the frogs, the serpents, the lizards, and the tortoises. Those which frequent the water have large lungs, containing more air than is necessary for their immediate use, and serving as reservoirs, from which oxygen is procured while they lie concealed beneath the surface. In birds and quadrupeds, whose temperature is much higher than that of the preceding classes, and the activity of whose muscular, nervous, and circulating systems is also greater, we find lungs of the highest degree of complication, the whole interior being divided and subdivided so as to secure the greatest possible amount of respiratory surface.

There is still another race of animals, which, though truly aquatic in their habits, occupy a position intermediate between the two divisions above mentioned. They constitute the order of *true* amphibious animals, being provided with internal pulmonary organs, and with external tufts or gills, so that they are capable of respiring either air or water. This is the case with the Proteus, the Siren, and the Axolotl. Some of the lower orders of reptiles, in their immature condition, have the same organization as the Proteus, which is intended, however, only for temporary use, the gills subsequently disappearing, but the lungs continuing to be developed, and, in the adult, the function being performed as in other air-breathing animals. The tadpole of the common frog is thus organized, the gills not disappearing until

it undergoes its metamorphosis, when its extremities are fully developed, and it becomes capable of terrestrial locomotion.

Having thus given a general view of the respiratory organs, as presented by the different classes, the author proceeds to an exposition of the *effects* of respiration; namely, its action upon the atmosphere, or upon the air contained in the water, the comparative amount of oxygen consumed, and carbonic acid exhaled, by man and the lower animals, the changes which the blood undergoes in its circulation through the respiratory organs, the causes of its change of color, in a portion of the animal kingdom, during its passage from the venous to the arterial system, and the theory of the chemical process. Lastly, he treats of the respiratory motions, and of the influence of the nerves on the different stages of the respiratory function. Having passed in review the different theories which have been advanced from time to time by Lavoisier, Laplace, Davy, and others, he sums up the present state of our knowledge on this subject as follows:

"Till within the last few years, therefore, the theory of respiration was involved in inexplicable difficulties. Blood agitated with atmospheric air was known to yield carbonic acid without the influence of the living organ, becoming at the same time of a bright red color; it was believed, however, to contain no preexisting carbonic acid; and yet frogs were found to exhale carbonic acid when no oxygen was respired, and in nearly as large a quantity as in atmospheric air.

"Now, however, the problem is satisfactorily solved. The excellent experiments of Professor Magnus have shown that both kinds of blood contain oxygen, nitrogen, and carbonic acid gas, that arterial blood contains more oxygen than venous blood, while carbonic acid is in larger quantity in the venous than in the arterial. During respiration, carbonic acid is extracted from the blood by the atmospheric air, oxygen being yielded to the blood in its place; a portion of the carbonic acid still remains, however, dissolved in the arterial blood. In the process which is constantly going on between the blood and the texture of the organs in the capillary vessels of the body, the oxygen, which is a vivifying stimulus for the organized substance, disappears in part from the arterial blood, and carbonic acid is formed; the venous blood, therefore, contains a larger proportion of carbonic acid, though it retains some of the oxygen. The venous blood

reaching the lungs is again deprived of a part of its carbonic acid by the action of the atmospheric air. The interchange of the carbonic acid and oxygen in the lungs is wholly in accordance with the physical laws of the absorption of gases. A fluid impregnated with a particular gas does not give it out as long as its surface is subjected to the pressure of the same gas; but, if it is brought into contact with a different gas, an interchange takes place until the gas with which the fluid is impregnated, and the gaseous atmosphere which presses upon it, are equally mixed. This law affords a ready explanation for the exhalation of carbonic acid by frogs in hydrogen and nitrogen in as large quantity as in atmospheric air, as well as for the fact that hydrogen and nitrogen transmitted through blood become impregnated with the carbonic acid which it contains.

"The proportion of carbonic acid contained in the blood is sufficiently large to account for the whole quantity exhaled from the lungs.

"Supposing that two ounces of blood are expelled from the heart at each beat, ten pounds must pass through the lungs in a minute; and these ten pounds of blood ought to contain 27·4 cubic inches of carbonic acid, — such being the volume of this gas which Allen and Pepys found to be exhaled from the lungs during a minute's respiration. But, admitting that the quantity of carbonic acid really exhaled from the lungs is less by one half than the experiments of Allen and Pepys would indicate, — and it certainly is less, — and adopting the estimate of Sir H. Davy, who calculated that 15·8 cubic inches is the amount of carbonic acid gas exhaled from the lungs during each minute, still ten pounds of blood ought to contain nearly sixteen cubic inches of that gas.

"The experiments of Professor Magnus have shown, that the blood contains at least one fifth of its volume of carbonic acid; and, since one pound of blood measures about 25 French cubic inches [one pound avoirdupois of water contains 27·7 English cubic inches, the same weight of blood about 26·4 English cubic inches], every pound of venous blood ought to contain at least five cubic inches of carbonic acid, and the ten pounds of blood which pass through the lungs in a minute, 50 cubic inches [60 English cubic inches], of which it may easily be conceived that 15·8, or even 27·4 cubic inches, may be exhaled in the respiratory process.

"A small quantity of nitrogen is absorbed by the blood from the air respired, but does not appear to perform any office in the system, since its proportion is the same in arterial and venous blood.

"The object of the respiratory process is evidently, first, the absorption of oxygen into the blood, which conveys that gas as a stimulus to the different organs of the body; and, secondly, the removal from the blood of the carbonic acid which is formed in the capillaries. That the latter is not the main object is clearly shown by the fact of frogs falling into a state of asphyxia when made to respire in hydrogen and nitrogen, although the quantity of carbonic acid which is exhaled in those gases is not in the slightest degree less than in atmospheric air." — Vol. I. pp. 357, 358.

We are aware that it is impossible, from a short notice like this, to form a true idea of the whole work under consideration; to this end, nothing short of attentive study will suffice. The student who shall avail himself of the treasures contained in it, will be convinced that Professor Müller, as might have been anticipated from his high European reputation, was eminently qualified for the great task which he has undertaken; and that, before entering upon his labors, he had acquired all the preliminary information essential to his success. He has a thorough acquaintance with physical and chemical science, and the anatomy of man and the animal races; and to these qualifications must be added an acute and philosophical mind, slow to admit the opinions of others, unless supported by substantial evidence. Nearly every page affords sufficient testimony of the truth of what is here advanced. We do not wish to imply, that no objectionable opinions are brought forward; some there certainly are, perhaps many; to discuss these in detail, however, is a business that falls within the province of journals strictly devoted to medical and physiological science.

With regard to the English edition of this work, we have no other remark to make than that it is in the highest degree satisfactory, not merely from the beauty of its typographical execution, but on account of the numerous marginal illustrations and diagrams, which are indispensable for a clear understanding of many portions of the text. With respect to the American edition, although we are by no means disposed to doubt the ability of its editor, or that he has performed his duty as faithfully as the circumstances would admit, we think that it is much to be regretted that any abridgment should be undertaken, especially since it often requires, as in the present case, the omission of im-

portant evidence, and the insertion of general and imperfect summaries. The absence of engraved illustrations in the body of the text must be regarded as a great objection to the American abridgment, and, should a new edition be called for, we trust that it will be found practicable to supply them.

ART. VI. — *History of Europe, from the Commencement of the French Revolution in* 1789, *to the Restoration of the Bourbons in* 1815. By ARCHIBALD ALISON, F. R. S. E., Advocate. Paris: Baudry. 1841. 10 vols. 8vo.

MR. ALISON'S History has many excellent qualities, and some striking faults. It is the elaborate and highly finished work of an able and conscientious writer, who has given to it the patient toil of many years, and who may be considered as having staked his reputation upon its success. It is not a brilliant production; it does not bear the marks of genius; it is not imbued with any profound philosophy. But it is full of interest, and it embodies a great amount of information, carefully collected, and admirably digested and arranged, and presented in a way that cannot fail to absorb the attention of the reader. It is conceived on a comprehensive plan, which admits every thing that can elucidate the main subject, without violating its unity; and it is executed with a care, fidelity, and spirit, that cannot be too highly appreciated. The author endeavours to be strictly impartial, and he is generally successful in the attempt. His work contrasts very favorably, in this respect, with the Life of Napoleon, by Scott, which is so full of English prejudices and unfairness, that, notwithstanding the great merits of its execution, it can hardly be said to possess any historical value whatever. This remarkable book always appeared to us like a sort of high Tory romance, or a plea in favor of Castlereagh politics, illustrated by a half fabulous account of French Jacobinism and the crimes of Napoleon. Mr. Alison's work has far higher claims to consideration and trust. Yet his Tory principles are as violent, and carried as far, as